

# **A Hierarchical Structure Approach for Multi-scale Representation in Road Networks of Common Patterns**

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## **Abstract.**

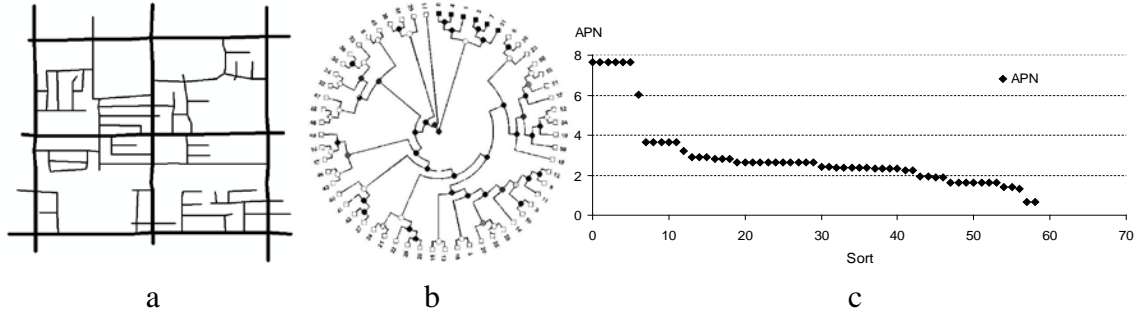
Road network is one of the focused elements in map generalization. Road network generalization can be considered as the combination of two operations. One is selective omission, and the other is the simplification of selected roads. Selective omission is the key operation. It is hard to maintain the overall and key local structure of original networks while consider the density and envelope of roads simultaneously.

Many solutions have developed in road selective omission with good effects. According to the construction of road networks, the methods of selective omission can be divided into two types. One is select line features of roads based on the linear dimension. The other is an indirect way which merges 'areal partition' or 'mesh density' constituted by several road segments. The selective omission of road segments is usually based on the importance of road and omits a certain percentage of roads below a certain standard. Semantic, geometry and topological properties are helpful for determine the importance of road. And some computational intelligence algorithms proposed based on the basic properties, like artificial neural network, genetic algorithms, agent and etc.

But previous solution did not achieve subsequent connectivity automatically and the correspondence between road networks in different scales. It will solve the problem if we can build the hierarchical structure of road networks. And a tree structure is a good choice to build it.

This paper presents a novel method for selective omission. The method could build the hierarchical structure of road networks. It is based on Hierarchical Random Graph (HRG) which transform a graph into a dendrogram and widely used in complex networks. It goes beyond simple clustering and provides clustering information at all levels of granularity with useful visualization. But it build too much hierarchies for multi-scale representation because its dendrogram structure. So after building road network into HRG we propose a measure named Accumulate Probability Number (APN) based on HRG to simply hierarchy. APN reflects the importance of each road in the whole. Classifying the sorted APN could simplify and build the hierarchical structure of road networks.

During the modeling of road network, it should be noted that we choose 'stroke' as vertices and the connection between them are edge when transform road networks into a graph. Result of a simple example shows in figure 1. The black solid leaves of HRG are the highest module of the whole leaves. The corresponding thick road strokes are trunk roads in the road network. In point chart of APN, the highest six points are corresponding to the thick road strokes too.



**Figure 1.** An example road network, its HRG, point chart of APN

The proposed approach is validated with case study applied to road network generalization, and implemented by different patterns of road networks include grid, ring-star-hybrid, grid-star-hybrid, irregular patterns. The corresponding Google Map is used as a benchmark for evaluation. The rendering results of APN match well with the benchmark. Figure 2 shows the result of a ring-star-hybrid road network. Last we use the number and length of coincide roads for quantitative evaluation. The results show well.



**Figure 2.** Rendering road networks compared with *Google Map*